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TELEPHONE EXCHANGES.

THE remarkable progress of the speaking telephone in America has been until quite recently in very striking contrast with its apparent neglect in the United Kingdom. In America, the country of its birth, it has been eagerly adopted, and telephone exchanges are now established in almost every city of consequence throughout all the States. It is estimated that there are now more than 40,000 telephones in use there. Chicago alone numbers over 2,000 subscribers to the far-speaking system which ramifies that busy centre of trade, and the process of introduction is rapidly being extended to minor towns, and even to remote settlements of the West. In the mining camps of Nevada and Colorado a telephone exchange is a sign of civilisation, almost as essential as a meeting-house or a bar-room.

Nor are these exchanges confined to the precincts of each city; they actually connect town to town, and thus enable the citizens of one town to converse with those of another, that is, if the distance between be not too great. Telephonic communication has, we understand, been successfully maintained during the middle of the day, when the difficulties were at their height, between Philadelphia and New York—a feat which has also been paralleled in England.

On the other hand, although the admirable invention of Professor Bell was received in this country with loud acclaim, and gave rise to a mushroom crop of popular lectures and scientific experiments, it fell quite flat upon the community in a practical sense. The original enthusiasm soon passed away, and a pernicious faith gradually got abroad that the instrument was merely an interesting toy, very amusing to a drawing-room full of ladies, or highly ornamental to the physical cabinet of a philosophical *dilletanti*, but utterly unfitted for serious everyday use. That this belief was erroneous, is amply demonstrated by the extraordinary success of the telephone in America. The characteristic slowness with which the English elect to throw off old habits and take on new ones, the prevalent dullness of trade, and, perhaps, a lack of enterprise on the part of those owning the appliance, have, also, had much to do with the telephonic standstill here. Our Post Office, unlike that of the German Empire, declined to take up the instrument, and Professor Bell was therefore cast upon his own resources. But he is understood to have been otherwise so hampered and retarded in his efforts to improve and introduce the telephone in England, that he was glad to make his escape to America again, where he could work with greater ease and more hope of practical success.

The triumph of the telephone in that country has, however, at length infected England, and telephonic exchanges are now being established in London and other large towns. The Bell Telephone Company have turned their Coleman Street office into a central station for the city; other stations are likely to be opened soon in the metropolis, and other towns, notably Manchester, are arranging to have exchanges. The time appears to be ripe for them, and the city merchants are waking up to the advantages which they offer for expediting their business. Already a considerable number of subscribers have come forward, and the system has got a flourishing start. The terms charged by the Bell Telephone Company from each subscriber are £20 yearly rental, everything being provided and maintained by the company. The Bell telephones employed as receivers are of the best American make, and a transmitter is used in order to give loud as well as distinct utterance. The exchange switch-board, call-bells, and other connections which have proved so efficient in America are also adopted by that company.

The discovery of the microphone by Professor Hughes undoubtedly reduced the value of Mr. Edison's carbon transmitter, which relied for its efficiency on the electro-magnetic telephone as a receiver, and that inventor, with characteristic pluck, thereupon set himself to perfect his electro-chemical receiver and make it fit to take the place of the electro-magnetic receiver, which was at the best borrowed from Prof. Bell or Mr. Elisha Gray. The English public have had many opportunities during the past winter of judging for themselves of his success in this difficult task, and at last a telephonic exchange, on the Edisonian model, has been opened at No. 6, Lombard Street, and a number of subscribers gained.

Mr. Edison employs slender steel wires, electro-typed with copper for his lines, so as to combine lightness, strength and conductivity. They are further covered with a slight coating of insulating material, which insures their insulation and durability in the moist, corrosive atmosphere of London. The electro-chemical telephone is "loud speaking;" but, by a simple mechanical contrivance, it is provided that conversation can be carried on without

being audible beyond the desired limit. A monthly rental is charged for the use of this system.

Now that the ice is broken, we anticipate that the telephone will be taken up with the customary energy of our countrymen, and we hope soon to see the whole of London, as well as other large cities, divided up into districts, each furnished with its central telephonic station.

ON LIGHTNING PROTECTORS FOR TELEGRAPHIC APPARATUS.

By WM. HENRY PREECE, Electrician, General Post Office.
(Read before the British Association.)

FOR many years it was not the practice in England to protect telegraphic apparatus from the injurious effects of atmospheric electricity because the damage done was so insignificant, and because the remedy was found to be worse than the disease.

But as telegraph systems increased—as the country became enveloped in one vast network of wires, it was found that the damage done became considerable, until, in fact, about 10 per cent. of the apparatus in use were in one year damaged.

Lightning protectors then became essential. Many forms were tried, based on the fact that when a discharge takes place through a non-conductor, such as dry air, at the moment of discharge the resistance along the line of discharge is practically nothing, and, therefore, all the charge is conducted away. According to Faraday, "the ultimate effect is exactly as if a metallic wire had been put into the place of the discharging particles." (*Researches*, series XII., 1406.) Most of those tried failed.

The survival of the fittest has been exemplified in the "plate" protector. In this form—one of the earliest introduced—one thick plate of brass is in connection with the earth, and another similar plate in connection with the line is placed above it, but separated from it by paper, or by insulated washers. The lightning, on entering the wire, bursts across the paper, or air space, in preference to passing through the apparatus, and thus escapes to earth.

An important modification of this plate discharger has been made by Dr. Werner Siemens, who, by serrating, or grooving with a pointed tool the opposing faces of the two plates at right angles to each other, converted them into a conductor, which was supposed to be one composed of an infinite number of opposing points. The remarkable action of points in facilitating discharge is well known, and their introduction into lightning protectors occurred very early in the annals of telegraphy, by Mr. C. V. Walker, F.R.S.

Messrs. Siemens' arrangement, very pretty in theory, never carried conviction of its value in the mind of the author, because protectors, so prepared, never singled themselves out as evidently superior to others that were not so prepared; and while the intersection of the grooves certainly formed mathematical points, they did not form physical or mechanical points, and it is upon the action of this latter kind of point that such remarkable electrical effects are produced.

Dr. Warren de la Rue, having very kindly placed his well known battery of 11,000 cells at the disposal of the writer, he prepared four plate protectors, identical in dimensions, excepting that two were serrated, and two were not. The two plates were separated from each other by narrow ebonite washers ·01 inch thick. The upper plate was placed in connection with the positive pole, and the lower plate with the negative pole. The number of cells were increased until a continuous current of electricity flowed.

1. PLAIN PLATES.

No. of cells.	Effect produced.
1,000 . .	Slight sparks just commencing on completing circuit.
1,080 . .	Sparks evident.
1,200 . .	Sparks frequent and abundant.
1,500 . .	Continuous arc.

2. SERRATED PLATES.

No. of cells.	Effect produced.
1,000 . .	Sparks just commencing on making contact.
1,080 . .	Sparks evident.
1,200 . .	Sparks frequent.
1,500 . .	Continuous arc, but fitful.

2,000 cells in each produced a continuous stream of electricity. The effect with 1,500 cells was decidedly more marked with the plain plates than with those serrated. The experiments were extremely pretty, and very decided in their character.

Hence it appears that grooving is not only of no use, but that it rather deteriorates the value of the protector.

These experiments confirm very decidedly the accuracy of the figures obtained by Dr. Warren de la Rue and Mr. Müller on the striking distance between two flat discs given by them in their paper read before the Royal Society (*Phil. Trans.*, vol. 169 : 77), where it was shown that 1,200 cells struck across ·012 inch. Here 1,000 cells struck across ·01 inch, which agrees perfectly with the curve produced by those observers.

It is the practice in the Post Office Telegraph Department to keep these plates apart by thin paraffined paper ·002 inch thick, so that the air space is really much thinner than that experimented upon, and the striking difference of potential only 250 volts.

Messrs. de la Rue and Müller have shown that for points and various kinds of surfaces opposed to each other, plain surfaces act the best for potentials less than 1,500 volts., and that points are only efficient for high potentials. Now, as it is doubtful whether atmospheric electricity causes much higher potentials in telegraph wires than 1,000 volts., it is clear that plain surfaces are the most effective for protecting apparatus. It is quite certain that such plates, plain and smooth, separated by an air space ·002 inch thick, will form very efficient lightning protectors.

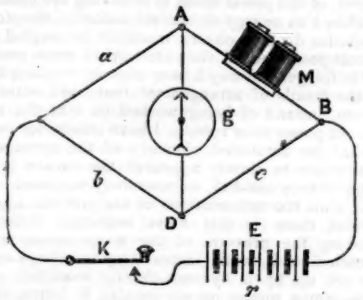
The author is very much indebted to Dr. Warren de la Rue for the performance of the experiments in his laboratory.

August, 1879.

A METHOD OF MEASURING ELECTRO-MAGNETIC DISCHARGES.

By H. R. KEMPE.

IT is sometimes required to compare the relative electro-magnetic discharges obtained from electro-magnets used in telegraph instruments. To do this the electro-magnet has been treated as a condenser, and the discharge measured by the well-known method with an ordinary discharge key. This arrangement is, however, a very unsatisfactory one, and does not give good results; it is very necessary that the adjustments of the key be made so that the contacts are very close together, otherwise a great portion of the charge is lost during the interval which elapses while the lever of the key is moving from the battery to the galvanometer contact, and even when the contacts are very close and the movement of the lever is very rapid, a portion of the charge is almost certain to be lost. The following arrangement for making the measurements I have found to answer very satisfactorily.



The magnet whose discharge is to be measured is placed in one of the arms of a Wheatstone bridge, and the key K being kept depressed balance is obtained on the galvanometer by adjusting c in the ordinary manner. When this is done, in order to obtain the discharge we have simply to release the key K, and the battery being thus taken off, the magnet immediately sends its *whole* discharge through the galvanometer and other resistances. If we wish to compare the relative discharges obtained from several magnets, we should first note the discharge deflection obtained from the electro-magnet with the highest resistance, and then the discharges from the other electro-magnets, inserting in the arm of the bridge along with them in each case a resistance sufficient to bring the total resistance in that arm equal to what it was when the first magnet was being tested. By doing this the currents exciting the electro-magnets in each case will be the same, and their discharges will consequently be directly comparable.

In order to obtain generally comparable results, we must know the current strength exciting the electro-magnet and the resistance through which the discharge takes place; then the value of the discharge deflection, in terms of the discharge deflection obtained from a condenser of a known capacity charged to a definite potential, will give us all that we require.

To obtain the current strength C exciting the electro-magnet, we have, since no current passes through the galvanometer,

$$C = \frac{E}{r + \frac{(M+a)(b+c)}{M+a+b+c}} \times \frac{b+c}{M+a+b+c}$$

$$= \frac{E(b+c)}{r(M+a+b+c) + (M+a)(b+c)}$$

and since $a c = M b$, or $c = M\frac{b}{a}$, we get

$$C = \frac{E\left(b + M\frac{b}{a}\right)}{r\left(M+a+b+M\frac{b}{a}\right) + (M+a)\left(b+M\frac{b}{a}\right)}$$

$$= \frac{E\,b}{r(a+b) + b(M+a)}$$

where E is the electro-motive force of the battery.

The resistance R, through which the discharge takes place, will be

$$R = M + c + \frac{g(a+b)}{g+a+b} = M + M\frac{b}{a} + \frac{g(a+b)}{g+a+b}$$

$$= (a+b)\left[\frac{M}{a} + \frac{g}{g+a+b}\right]$$

If d be the discharge observed in the galvanometer, then the value of the discharge D obtained from the electro-magnet will be

$$D = d \times \frac{g+a+b}{a+b}$$

This quantity (D), compared with the discharge obtained on the same galvanometer from the condenser charged from a standard electro-motive force, a Daniell cell for example, gives the means of comparison required.

This method of measuring a discharge may be applied with very great advantage to the tests for "localising a complete fracture," and for "localising a partial disconnection" in submarine cables, described in the numbers of this Journal for April 1st, 1876, and February 1st, 1878, respectively. In each of these cases the cable would be connected to the point A, whilst the point B would be put to earth. Then when balance is obtained, $\frac{a c}{b}$ gives the resistance of the cable, and the throw on the galvanometer when the key is raised gives the discharge, the value of which has to be multiplied by

$$\frac{g+a+b}{a+b}$$

The discharge from the cable takes place, of course, through a resistance

$$\frac{g(a+b)}{g+a+b} + c$$

which has to be inserted in the place of G in the formulæ given in the articles referred to.

The great advantage of this system, irrespective of the most important point that it allows none of the discharge to be lost, lies in the fact that the discharge will be measured at the very moment when the resistance is known, for the discharge will not be taken till the needle is at zero, and at that moment, as has been pointed out, the resistance equals $\frac{a c}{b}$.

ELECTRICAL SCIENCE AT THE BRITISH ASSOCIATION.

Electricity as a Motive Power.

By Prof. W. E. AYRTON.

Discourse delivered August 23rd, 1879, to the Working Men of England.

(Continued from page 283.)

Again, although we have only a small flow of water, so that little of the energy will be lost from friction, the pipes must be made extremely strong to bear the great pressure, and consequently must be expensive, also it will be extremely difficult to prevent contraction and expansion of the pipes starting leaks at the joints. Now, with the water at a very great pressure, and with a very slow flow along the pipe, a very little leakage will represent a large percentage loss of energy.

Although, therefore, as far as friction in the pipes only is concerned, a very high pressure at the reservoir, combined with the use of turbines in the town, working at a high pressure, furnishes a very economical mode of transmitting power, it is quite impracticable except for short distances.

Now, the conditions for economically transmitting power by electricity are, as we shall see, *identically* the same as those we have arrived at for the transmission by water in pipes, but luckily they are not in the electrical case by any means impracticable.

In any generator of electricity there is a certain property called the electro-motive force, which means its tendency to send a current and which is analogous with the head of water in a reservoir, inasmuch as the product of the quantity of electricity flowing per second, multiplied by this electro-motive force, measures the amount of energy furnished by the generator per second, and which could be reproduced as motive power elsewhere if there were no friction. Now, the loss of energy due to electrical friction in the wires is equal to the square of the current flowing per second multiplied by what is called the resistance of the wire, a number depending on the length, the diameter of the wire, the material of which it is made, and the temperature.

Now, I explained to you that when an electro-motor was working it produced a back electro-motive force tending to diminish the current. The maximum work that can be given out by this electro-motor per second, if its efficiency is unity, that is, if there is no friction or other loss of power, is equal to the product of the current into this back electro-motive force. There are two ways, therefore, of altering the work given out by the electro-motor per second. Either we may increase the current, or we may increase this back electro-motive force. Let us consider the first case: we will double the current; then assuming that the electro-motive force of the generator remains the same, which in the water question is equivalent to assuming the height of the reservoir above the town constant, we should have to let the electro-motor run at such a diminished speed that the difference between the electro-motive force of the generator and the back electro-motive force of the electro-motor is double what it was before. Although, therefore, we have doubled the current, and the energy furnished by the generator, we have not nearly doubled the energy given out by the motor, and the reason of this is obvious, since as the waste of power in the production of heat in the wires is proportional to the square of the current, four times as much power will be wasted as in the previous case.

Consequently, just as in the case of water, increasing the current is a ruinous way of increasing the transference of energy.

Now, take the other case: assume that we double the electro-motive force of the generator, and run the motor at such an increased speed that the current remains constant; to do this we must more than double the back electro-motive force of the motor. The energy now furnished by the motor will be double what it was before, the energy given out by the motor will be more than double what it was before, and the energy wasted in heat will be exactly the same as before.

Consequentiy, just as we concluded in the case of the water, that the most efficient method to employ in order to transfer the energy, was great pressure in the reservoir, combined with turbines in the town working at a high pressure, so now we conclude that the most efficient way to transfer energy electrically is to use a generator producing a high electro-motive force, and a motor producing a return high electro-motive force; and by so doing the waste of power in the transmission ought, I consider, to be able to be diminished with our best existing dynamo-electric machines to about thirty per cent; for, as experiment shows the efficiency of our best existing dynamo machines to be 0·86 (that is 86 per cent. of the power spent in revolving the bobbins is reproduced as energy of electric current); therefore, if two similar dynamo-electric machines be coupled up to transmit power, and if they are worked most *economically* in the general way I have already explained, and with the details of arrangement that I will enter into later on, instead of being worked so that the motor gives out power *most rapidly*, I have reason for expecting that the combined efficiency of the arrangement can be made to closely approach the square of 0·86, and not merely one-half, as commonly supposed.

But while the two solutions of the problem are thus identical, there is this most important difference: increasing the pressure of the water means an uneconomical task, while increasing the electro-motive force set up by a dynamo-electric machine, or an electro-motor, means merely running it faster, or running it at the same speed and putting more wire on the rotatory portion.

And again, assuming that the mean electro-motive force between the wire and the earth be as much as one hundred times the electro-motive force producing the current, namely, the difference between the electro-motive forces of the generator and of the motor, then with the ordinary insulation of the best land telegraph lines, less than one per cent. of the energy transmitted ten miles would be lost by leakage.

It would be impossible to increase indefinitely the speed of revolution of the cylinder of an induction machine, since apart from mere mechanical friction the iron constituting the core of the revolving part has to be magnetised and demagnetised very rapidly as it revolves. Now, there is a physical limit to the speed with which this can be done, and in addition this rapid change of magnetism heats the iron very much. But experiment shows that at the ordinary speed of revolution of dynamo-electro machines, 700 turns per minute, the electro-motive force is proportional to the speed. We are, therefore, very far yet from the limit of speed. Consequently it would be well for the transmission of power to attempt first, a considerable increase of speed in the generator, combined with so light a load on the motor, that its speed is also very high. When this begins to fail as larger and larger amounts of power are transmitted, then we might begin increasing the amount of wire on the revolving coils of each; but this, of course, has the objection that the loss

of power from a given current would then become somewhat larger.

In some of the dynamo-electric machines, the current that is sent through the external wires is the same as that which circulates round the fixed electro-magnets to create the magnetic field in which the movable coils revolve. Now, the small current which I am here advocating should pass between the generator at the one end of the line, and the electro-motor at the other, would be too small to properly magnetise the fixed electro-magnets of the two machines, so that even a high speed of the bobbin will not produce a high electro-motive force. But this diffiulty is easily overcome by the plan already employed, for totally different reasons, by Gramme, Lontin, and Wilde, in their generator for producing currents for electric lighting, viz., that of using either a separate exciter, or a separate portion of the revolving bobbin in the generator, to produce the current to magnetise the fixed electro-magnets. In connection with this current for exciting the fixed magnets, it is worthy of notice in passing, to observe that since experience shows that the electro-motive force of a dynamo-electric machine is proportional to the velocity, I conclude that the magnets are saturated, and that the exciting current is already too strong, so that it may be with advantage reduced, or many fewer coils of wire employed in this portion of the machine.

We have then been led to this most important result, which I hope is clear to you all, and which I trust you may all carry away with you,—*that a dynamo-electric machine, with a separate exciter, driven very fast with a steam engine, or with a stream of water, at high or low pressure, and sending by even quite a fine wire a small current to a distant electro-motor, also running very fast and magnetised by a separate exciter, is an economic arrangement for the transmission of power.*

We have seen then how to transmit electrically any amount of power through a fine wire. Now, how is this result affected by increasing the distance? Suppose we double the length of the wire, keeping the same thickness, then if we make the generator larger, putting twice as much wire on the main part of the revolving bobbin, and also make the motor at the other end larger, putting also twice as much wire on it, and if we run each at the same speed as before, then everything will be doubled, the electro-motive forces and resistances; in fact, twice as much work will be furnished by the generator, exactly twice as much as will be lost in conversion into heat, and about twice as much by leakage, so that the amount given out by the electro-motor at the other end will be about twice as great. Consequently, if we make the distance 100 times as long, using just the same thickness of fine wire, almost the same proportion will be lost as was wasted in the transmission over the short distance, provided 100 times as much energy is transmitted per second.

Electric transmission of power then becomes not only practical, but very economical both for short and for long distanecs, if we run both the generator at the one end of the line, and the motor at the other sufficiently fast, and if we only require to transmit a sufficiently large quantity of power.

But this latter requirement is the essence of all successful trades, viz.: that the percentage of profits shall increase as the operations grow in magnitude.

We have been considering the transport of power derived more especially from natural sources; but since we have seen that by the use of electricity, properly employed, the waste of power in transmission can be reduced for any distance to about thirty per cent. of the whole power absorbed at the generator, it follows that the employment of steam engines of vast size at points outside Sheffield, would be by far the most economical mode of extracting the energy out of coal. For it is at least four times as expensive to produce power with a small steam engine as with a large one; therefore including the waste of power in electric transmission, the cost of production of power in small workshops would be little more than one third as dear as if small steam engines were used, and similarly the waste of power in any large mill or factory in its transmission from the large steam engine at its base to all the floors and machines on each floor would be very much diminished.

Consequently it would be much more economical to work this lathe on the platform, as I will now proceed to do, by a big steam engine in Howard Street, several hundred yards away, than to use a small steam engine here for this purpose

But you will say that in advocating the employment of electricity I am advocating a total change in our mode of producing and transmitting power. Is the probable gain worth the expense of the necessary change?

To answer this question we must consider what would be the probable minimum annual gain by the proposed change in Sheffield alone. In making this calculation we must remember that not only can electricity produce motive power, but also heat and light, and electric heating and lighting have this great advantage that no chimneys are required.

For example, with the electric current sent here from Messrs. Walker and Hall's works I can heat this long coil of iron wire white hot, so that when put into the vessel of water, the water, you see, in a short time begins to boil. In fact, the stoker has put coal on the fire at Howard Street and boiled water with it here in the Albert Hall.

Again, it is almost needless to tell you that electric lamps can be lighted by a current produced at a considerable distance from the lamp, seeing that I have been using several times, for projecting images on to the screen, an electric lamp fed by the current produced in Howard Street. However, we will now light up this entire hall by one electric lamp, receiving its current from the same workshop, and by another for which the electric current is produced in the yard of the Sheffield Water Company by a water engine, and transmitted by the wires crossing the street, as shown in the diagram.

Various calculations have been made as to the relative cost of lighting by burning coal to produce gas, or by burning coal to work dynamo-machines for producing electric currents, and it seems to be pretty certain that if a large amount of light be required in one place, that the electric light is at least twenty times as cheap as coal; Sir William Thomson, our eminent electrician, goes as far as to say that it may be made 133 times as cheap. And certainly that there is a great saving in expense in electric lighting is seen from the actual result obtained at the Albert Hall, London, which is an example, and perhaps the only example in connection with electric lighting, where the science of putting a brilliant light high up has been allowed to ride over the precedent of putting a number of feeble glimmers all over a building.

Now, the duration during which the electric light is used at the Albert Hall on any one evening is only three hours, the time of the performance, so that the cost of getting up steam before the light is used, and the waste of heat after the engine is stopped, constitutes an important part of the whole expenditure. However, including this and other disadvantages under which Dr. Siemens labours in this matter, the actual cost, including labour of men, allowance for wear and tear of machinery, &c., is only one-third of that of the former

inferior gas lights, and thus a saving of about thirty shillings an hour has been effected.

And in addition to this money economy, a great and almost unexpected gain has been attained. For the smaller amount of noxious gas produced in the electric arc, than in burning the necessary amount of gas to produce even an inferior light, makes ventilation at the Albert Hall, London, now a less important question. And the smaller amount of heat at present produced causes less draught, so that taking the two things together the air is much more steady. But steady air of uniform temperature is very transparent for sound, while layers of air of unequal temperature are opaque to sound. Consequently this stillness of the air, arising from the use of the electric light, enables the singing and music to be better heard, an advantage of enormous importance in so gigantic a concert hall. As a striking contrast with the delightful coolness of the air at the Albert Hall, London, was the warmth of the brilliantly gas-lighted ball-room at the Cutlers' Hall on Thursday evening, and which was only surpassed by the warmth of the reception offered to the British Association by your Master Cutler.

Lighting streets by electricity has not been so successful, economically, for the simple reason that instead of having a large bright light, at a considerable height, reflected downwards, as in the Albert Hall, London, English conservatism has prevented the authorities from grasping the possibility of using for street illumination anything differing from an ordinary iron lamp post. But there can be little doubt that if a few large electric lights, high up, were used for street illumination, the same sort of result as has been obtained at the Albert Hall would be arrived at.

And in connection with the general illumination of a town by electricity there is this important fact to be borne in mind, that all experiments lead to the result that the larger are the dynamo-machines used for producing the electric light, the cheaper is the light produced per horse-power. For example, with this smallest Siemens' machine, which I have on the table, one horse-power gives 600 candles, whereas with the larger machine, such as we are running backwards for driving our emery wheel, circular saw, &c., one horse-power gives 1500 candle power, more than double the light furnished by the other machine; and it is said, although I cannot vouch for the fact, that with the very large machines used in lighting the Palais de l'Industrie in Paris, 6000 candles were obtained per horse-power.

At any rate we may be absolutely safe in saying that the cost of using gas in Sheffield for lighting large halls, such as the one we are now in, factories, and the streets, could be halved if electric currents, generated by water engines worked by hill streams, as well as by very large steam engines, were substituted for gas.

But can this be quite right, for I have proved that to transfer energy economically we must use a large pressure and a small flow. Now, how can we produce a very bright electric light with a small current? Why, by not using the current that comes along the wire to produce the light at all, but merely to drive an electro-motor, which motor, at the place where any large amount of light was required, would be employed in giving motion to a second dynamo-electric machine, which would produce the currents for lighting purposes.

This experiment I might show you, but as we have used already several times during the evening electric lights fed from a distance, we will vary the experiment and try an analogous one. Messrs. Walker and Hall will now, at their works, give rapid motion to a dynamo-machine, and the current which, when properly arranged as I have explained to you may be small, will set in motion this electro-motor. This in its turn will cause this other dynamo-machine to rotate rapidly and produce a current which I will use for rapidly gilding this piece of plate.

It is not necessary for me—and, in fact, time would not allow me—to tell you how I propose to employ the electric light to illuminate private rooms, if only I can get people to throw away the notion that to light a room we must have something with a globe on it, like an oil lamp; nor is it necessary for me to remind you that by whitewashing the walls, yes by whitewashing even the very machines themselves in some of the Paris factories, the supposed strong shadows cast by the electric light have been less than the strong shadows cast by another bright light, one that we not only put up with, but one that from the force of habit we are tolerably contented with, viz., the sun.

At present, I am concerned with the pounds, shillings, and pence question, which has more than usual weight in these days of slack trade. Well then, assume the cost of gas used for lighting the large buildings, factories, and the streets of Sheffield can be halved, also, that where it is used for heating purposes the expense can also be halved, by substituting electric currents generated by very large steam engines at certain points, and by turbines driven by falling water out of the town; then you would save per year about £45,000. Suppose, also, that the cost of producing motive power can in the same way also be halved, this represents an annual saving of something like £60,000. In reality, I believe this last economy would be larger, since not only could power be produced so much more economically than by small steam engines or even by a large engine, when a large proportion of its power is, as now, wasted in driving the shafting alone in your factories; but, in addition, much hand work could be economically replaced by machine work. And, lastly, suppose the consumption of coal in Sheffield for heating your metals and for heating your houses could also be halved, then there is another saving of about £300,000 a year, or, altogether, the annual saving that might be produced in this town alone, by substituting electricity for coal would be something like the large sum of £400,000.

It is hardly necessary for me to point out to you how much capital a company would be willing to advance for such a comparatively certain profit yearly, or whether a large portion of this saving could not be effected by expending only a portion of this capital.

But I think I hear you saying this is all very nice, but there must be certainly something wrong in it all: is it likely that Sheffield could save £400,000 a year by merely using machines to whirl round coils of wire to produce electric currents?

If that be the impression this lecture is producing in your minds, and I can hardly expect the more thoughtful to at once accept the truth of so novel a reform as I am here advocating this evening, and which probably you are listening to for the first time, allow me to adduce the following arguments to prove that although the reform is startling it may still be sound:—Imagine the cost of cutlery and plated goods to remain the same as at present, but all machinery to be removed from Sheffield, then what an enormous loss would accrue to the town from everything having to be done by hand labour. The saving then I am showing you how to obtain, enormous though it may be, is still small when compared with the gain that the introduction of machinery during the last hundred years has effected for this town.

Or again, it may be objected that I talk of using water power at the hillside to drive turbines. But this water cannot come afterwards into Sheffield for drinking and other purposes, because to do work it must lose

head. We must therefore waste at the source all the water we use for power. But has the Sheffield Water Works any water that can be thus dispensed with in the town? Assuredly, thanks to the energy and perseverance with which the Sheffield Water Works Company have conducted their operations, there is always in hand a very large stock of water. For instance, at present there is in the reservoirs at Redmires, Rivelin, Agden, Strines, &c., enough to last the town for six months if not another drop of rain falls (which is a far more unlikely occurrence than that every Sheffield manufacturer will speedily adopt electricity), and when the reservoirs at Damflask and Dale Dyke, now completed, but not yet in use, are employed, there will be at any time, I understand, a year's supply of water in the reservoirs, even if the consumption of Sheffield somewhat increases.

Bearing this in mind as well as the fact that the Company has also power to construct two other reservoirs, in the Ewden Valley, it will be seen that there is no lack of water, and I am sure there will be no lack of willingness on the part of the Company to allow water at the source to be used, especially when such an arrangement can be made renumerative both to themselves and to the manufacturers.

As an example of what water power can do, we will now cut a two-inch board with a circular saw driven by an electric current produced by the water motor in the yard of the Water Company, and conveyed to this hall by the wires crossing the streets.

So much for what may be done by electricity in producing motive power. Now, let us consider what has been actually done. Last year, two French engineers, MM. Chrétien and Felix, at Sermaize (Marne), actually ploughed fields by electricity, the electric current being produced by two dynamo-electric machines, of a form invented by M. Gramme, and shown in the diagrams on the walls. These machines were usually worked with a steam engine at some convenient place three or four hundred yards away in an adjoining road and the electro-motors were also two Gramme machines, one on each side of the field, with their coils revolving of course backwards. Through one of these, the electric current was sent alternately so that motion was given to one or other of two large windlasses, one on each of the waggons containing the electro-motors. In this way the plough which could be used going in either direction, was first pulled across the field making a furrow, and then back again making another parallel furrow.

A photograph, taken on the spot, of one of the complete Gramme electro-motors, with its windlass and waggon, together with the double acting plough, will now be projected on to the screen.

A second photograph is now projected on to the screen of M. Chrétien's electric crane for unloading boats. This also has been successfully employed for several months at Sermaize, in the harbour there, and it is considered that a saving of about thirty per cent. has been effected of the expense formerly incurred for unloading the sugar barrels out of the boats.

If electricity were produced in large quantities at certain centres, then one difficulty that would of course be met with would be that of distributing it properly, since, just as in the case of water or gas, if a large branch pipe in a main be suddenly opened then the supply going on to the other branch pipes in the same main will be diminished, a result causing serious inconvenience in the case of electric lighting. But just as automatic governors have been devised for water and gas, to keep the supply constant, so automatic "electric current regulators" have been devised by M. Hospitalier and by Dr. Siemens, to keep the current constant. One of those invented by Dr. Siemens is on the table before you, and the general principle of its construction is easily understood. As the current passes through the regulator it heats a certain very thin ribbon of steel, which consequently expands. The effect of this expansion is to introduce coils of wire into the circuit, the extra resistance of which diminishes the strength of the current. Consequently the stronger is the current the more is it automatically resisted, and the weaker it becomes the less is it resisted, and so it remains practically constant at any desired strength for which the regulator is previously adjusted.

The peculiar advantage of Dr. Siemens' regulator is its rapidity of action, since, as the strip of steel has very little mass and a large radiating surface, its temperature alters very rapidly for a small change in the amount of heat produced in it per second, that is, for a small change on the current flowing through it.

But our electric current would be affected in another way. While the supply of energy and heat required in a town is fairly constant from day to day, the velocity of water on hill streams is great after floods, and small in dry weather. Must we, then, have a sufficient supply of dynamo-machines, so that even in a drought we can transmit, electrically, sufficient power; if so in times of rain, like the present, the waste of water power would have to be enormous; or is it possible in any way, cheaply, to store up electric energy during an abundance, and use it during a scarcity? Assuredly, cannot we decompose acidulated water producing oxygen and hydrogen, an operation which experiment has shown will go on quite as easily when the gases produced are under enormous pressure, and occupy very little space, as when the gases are only under the pressure of the atmosphere, as they are in this voltameter from which you observe they are coming off as I pass the current through it. In these two very thick iron bottles I have stored up, under enormous pressure some of this oxygen and hydrogen, and we will liberate a little of the bottled up energy, producing, as you see, this bright oxy-hydrogen light.

Now, assume the pressure of the gases in these bottles is only thirty times as much as the ordinary atmospheric pressure, then the energy given out by the hydrogen contained in one of these bottles, only a square foot inside, combining with the compressed oxygen, in another bottle, having its internal capacity only half-a-square foot, would be no less than 110 million foot pounds, or about the same as 60 horse-power developed for one hour, or one horse-power developed for two days and a half.

Decomposing acidulated water under great pressure by means of the electric current not only then enables us to store up electric energy, but to store it up in an extremely compact way.

But is there no other side to this question? We are, it is true, a commercial people, but do we not still love our hills and our fields? There was a time when the cutler of now black, grimy Sheffield was very fleet of foot in following the chase. There was a time when "Not only in the villages around old Sheffield," so says the history of Hallamshire, "were the file makers' shops or the smithy to be seen, with the apprentices at work; but even on the hill-side in the open country, at the end of the barn would be the cutler's shed, whilst in the valley below, by the river, was the grinding wheel ready to sharpen the tools that had been manufactured."

And why not now? Why should not that mountain air that has given you workmen of Hallamshire in past times your sinew, your independence of character, blow over your grindstone now? Why should not division of labour be carried to its end and power brought to you

instead of you to the power? Let us hope then that in the next century electricity may undo whatever harm steam during the last century may have done, and that the future workman of Sheffield will, instead of breathing the necessarily impure air of crowded factories, find himself again on the hill side, but with electric energy laid on at his command.

Time will not allow me to tell you more. Some of my ideas regarding electric transmission of energy you have heard; and whether you think these ideas are right, or whether you think them wrong, I venture to hope they may be regarded as worthy of careful consideration, for let it not be said that you, that I, that any of the workers of Great Britain, are allowing by a disregard of scientific principles, are allowing by a neglect of technical education, England's far famed pre-eminence to pass away; let rather our grandchildren, as did our grandfathers, hear that in all that is right, England takes the lead; and when we find we can no longer maintain that superiority by the abundance of our coal, then let us maintain it by the abundance of our knowledge.

Some Experiments with the Induction Balance.

By W. CHANDLER ROBERTS, F.R.S., Chemist of the Mint.

MR. ROBERTS stated that the instrument, which we owe to Prof. Hughes, the discoverer of the microphone, appeared to be one of no ordinary importance; and although the experiments about to be described were far from complete, they possessed sufficient interest to warrant their being submitted to the Section. He then described and exhibited Prof. Hughes' instrument, showing the extreme delicacy by which changes in the induced current were indicated by the microphone and telephone.

The relative values of different metals, as indicated by the induction balance, do not accord with the values usually accepted as representing the relative conductivities of the respective metals, and, this being the case, Mr. Roberts had ascertained what relation the indications given by alloys, when under the influence of the induced current, bear to their electric conductivities.

The experiments on a comprehensive series of alloys proved that, in the case of alloys of certain metals, the induced current curves closely resembled those representing electric conductivity, but that, in certain other cases, the induced current revealed differences that had hitherto escaped observation. As an example, Mr. Roberts alluded to the curve of the copper-tin alloys, in which there is a sudden break between the points representing two alloys, which only vary by a single equivalent, or by 6·4 per cent. of copper. These two alloys are widely different in colour, fracture, density, and structure, and the induction balance at once afforded evidence of a marked difference not shown in Matthiessen's curve of electric conductivity.

It is known that certain metals, when alloyed, undergo a molecular change, and that an allotropic condition may, in some cases, be induced by alloying a metal with a small quantity of another, facts which will, doubtless, receive careful examination from those who are pointing to the non-elementary character of certain metals.

Mr. Roberts then referred to the question of applying the induction balance to the assay of metals. In the case of gold-silver alloys, the instrument will show the presence of less than two grains of gold in the pound of silver. On the other hand the silver-copper alloys used for coinage are situated at the flat portion of the curve, so that it is impossible to detect even considerable differences in their composition; and these alloys, which are very peculiar in their nature, appear to be greatly affected by annealing. More hopeful results were obtained with the gold-copper alloys, and Mr. Roberts demonstrated a difference of 1 per cent. in the standard of two gold discs, which, though far short of the existing method of assay, in delicacy appeared to afford grounds for the belief that very accurate results will ultimately be obtained.

Recent Advances in Electric Lighting.

By J. N. SHOOLBRED, C.E.

THE author said that twelve months ago very little was, comparatively speaking, known of the electric light, whereas now there was no town in England of any magnitude in which experiments had not been made. The progress in the electric light had been very great. The great desideratum was the production of a number of smaller lights of less intensity in place of producing one light only of great intensity, and great progress had been made towards the solution of the difficulty. The question of the relative sanitary effects of the illumination by electricity and also by gas had received considerable attention, and the result had been considerably to the advantage of electric illumination. The author then gave an explanation of the various processes of electric lighting now in vogue, in the course of which attention was drawn to the lamp of M. Heinrich, a description of which we illustrate elsewhere.

On the Retardation of Phase of Vibrations transmitted by the Telephone.

By Professor S. P. THOMPSON.

DUBOIS-REYMOND predicted from theoretical considerations that a difference of phase, amounting to a quarter of a complete vibration, would be found to exist between the diaphragms of two Bell telephones, joined up in one circuit, the receiving telephone being a quarter of a vibration behind the transmitter. Helmholtz and Weber theoretically predicted only a small difference of phase. Recently König in a series of delicate experiments, effected an optical comparison by the method of Lissajous, of the vibrations of a pair of telephones, replacing the vibrating discs by tuning-forks armed with mirrors. The author has proposed the following method of observing. A pair of Bell telephones are suspended by wires of about a metre in length, so as to oscillate as pendulums, to frames so disposed as to avoid the possibility of any mechanical transmission of the vibrations. Below the point of rest of each telephone, and at some little distance from it in the plane of its swinging, is placed a steel magnet. After the lengths of the wires have been so adjusted that the telephones will swing in identical periods, one telephone is set swinging. As it alternately approaches and recedes from the magnet, the induced currents traversing the second telephone set it swinging. In every case the difference of phase observed amounted to one quarter.

In the case of those telephones which transmit vibrations by varying the resistance of the circuit,

instead of varying the electro-motive force, there is no such retardation of phase produced in the ordinary electro-magnetic receiver. If, however, the current so transmitted is first passed through an induction coil, a retardation of phase of one quarter is produced, and in the case of several successive inductions the retardation amounts to an additional quarter for every additional induction. This remark applies only to vibrations of harmonic and quasi-harmonic type.

In the case of Edison's motographic or electro-chemical receiver, the velocities, not the displacement of the disc, are proportional to the strength of the currents received. Hence vibrations already retarded one quarter in transmission, as is the case with those of the carbon transmitter in conjunction with its induction coil, always used with this instrument, are restored to their primitive phase. The vibrations of this receiver therefore agree with those corresponding to the function of which the vibrations of the induction current are the derivate; that is to say, they agree in type with the primitive vibrations of whatever form. In the receiving telephone of Edison, therefore, consonantal sounds which depart widely from the purely harmonic type are better rendered than in a telephone which like that of Bell both retards the vibrations in phase and alters them in type.

Report of the Committee on Atmospheric Electricity in Madeira.

By DR. M. GRAHAM.

REMARKABLE fluctuations of the electric potential were noticed at the time when the maximum potential is reached, which takes place at 11.30 a.m.; this fluctuation the writer ascribes to masses of cloud on moist air. The daily formation of a thin stratum of cloud during fine calm weather which varies slightly in altitude in accordance with temperature and barometric pressure was described. The electricity below this cloud is always positive and moderately strong. In the cloud itself it is more feeble but of the same sign. Above the cloud at the station where the observation was taken it was very feeble and irregular but always positive. In warmer weather the vapour does not condense into cloud but appears as a blue transparent haze from above, and presents the same electrical indications.

The highest potential was observed upon a rock ninety feet high, a few metres from the shore in the Bay of Funchal.

The thinness of the currents of air constituting sea breezes was demonstrated by flying a kite vertically beyond into the true wind blowing in a contrary direction. Abortive attempts were made to bring down the upper electricity through the lower currents. The electricity of the general north east wind which is identical with the trade wind was found on the heights at the east end to be uniformly moderate and positive.

At the approach of rain-clouds at the termination of a period of fine weather the atmosphere invaribly gives increased readings and no negative observations were recorded.

The L'este, a kind of sirocco to which Madeira is occasionally subject, electrically gives no indication of any change whatever except by faint fluctuations about the earth reading.

During the prevalence of L'este wind, the writer noticed a very highly electrical condition of certain clouds which lie quietly among the mountains, though tossed and tumbled on their upper surfaces; he hopes to be able to connect their forms and immobility with their electrical change.

HEINRICHS' ELECTRIC LAMP.

By C. F. HEINRICHS.

THERE have been lately many systems of electric lighting shown to the public, in which the production of small lights for the purpose of superseding gas has been quite successfully effected; but, from a financial point, they have not been quite satisfactory, as the unpracticability of the subdivision of the electric current for lighting purposes without loss has been often proved.

The only field in which electric lighting has already superseded gas, both as regards its being superior in illuminating power, and also its being actually cheaper than gas, has been where large lights (1,000 to 6,000 candle power) have been employed, and in which the consumption of the carbon pencils has been regulated by clockwork.

The only drawback in this line has been the inefficiency of the regulating mechanism; thus the light becomes extinguished frequently, and in some lamps it takes from 4 to 10 seconds before they are relit, and a disagreeable flicker is the result.

In almost all regulators, where the consumption of the carbon is regulated by clockwork, in conjunction with an electro-magnet, the current which produces the light has to pass through this magnet, and the increase or decrease of the current increases or decreases the attracting power on the armature of the same, which stops or releases the clockwork. I have found always that when the armature releases the clockwork and the carbon feed, the increase of the current does not take effect at once, not in proportion to the feed, and not until the arc covers again sufficiently and equally the new advanced mass of the positive carbon, and this sometimes takes from 2 to 10 seconds of time. Now in this time the clockwork is free, and the carbons keep feeding, and, therefore, are liable to come too close together, which produces the disagreeable hissing noise so often observed; or else, by the carbons coming quite together, the great increase in the current flowing in the circuit causes the generator to become heated, and its insulation thereby to be impaired.

That the increase of the current does not take effect at once when the carbons feed, will be explained by the fact that the heated carbon is a better conductor than the cold, therefore the current cannot rise to its maximum power until the new advanced mass of carbon is equally heated, and not until then does the arc equally cover the positive carbon; when again the arc becomes most conductive, and the current most powerful, then by its acting upon the armature of the magnet, it prevents the carbon from further feeding.

It will, therefore, be evident that regulators should be so constructed that when they are extinguished by accident they shall re-light instantaneously; and, secondly, that the carbon points shall never come actually in contact while burning.

The last point has been already effected by the candles of Jablochkoff, Wilde, &c., in which the arc is kept always of the same length. But these candles burn only with alternate currents, and the continuous currents have always proved their superiority in light power against alternate currents; also as

several small continuous current dynamo-machines can be placed on the same shaft, *i. e.*, constructed in one machine, therefore there is nothing to prevent the continuous current dynamo eventually superseding the alternate current machine if the successful introduction of regulators and candles, in which the before mentioned obstacles are overcome, can be effected.

J. N. Shoolbred, C.E., in his paper read before the British Association in Sheffield, exhibited among other novelties, Charles F. Heinrich's regulators and candles in which the carbon points can never come in actual contact while burning, and in which the light if accidentally extinguished, is relit partially instantaneously; the lamps also possess several novel features, which are very advantageous, when large open places and public halls have to be lighted up.

Perhaps the chief novelty in the regulators and candles lies in the application of *circular* carbon pencils, instead of straight ones. This in the first place triples the burning time. Secondly, the circular carbon pencils allow these lamps to be so constructed that the mechanism which holds the carbon is placed *above* the arc; the inconvenience and loss of light caused by the shadow of the mechanism which exists in most other lamps is thus avoided.

Figs. 1 and 2 show the regulator by which the feeding of the carbons is effected.

From Fig. 2 it will be seen that the metal arms that hold two carbon pencils are kept apart by two chains (which may with advantage be two racks) connected with the regulating mechanism. The two arms fall in different directions by their own weight, but by crossing one of the chains the pulley to which both chains are attached will move in only one direction. This pulley gears with the spindle to which is fixed an escapement wheel and a ratchet wheel; upon this ratchet wheel the lever to the right with the pawl acts, and by its movements separates the carbons, and upon the escapement wheel the lever to the left with the two pallets acts and regulates the feed of the carbons in the following manner:

When a current is sent through the carbons for producing the light, it has to pass through both the magnets, as shown in Fig. 1, this will cause both armatures to be attracted, thus bringing both levers in action.

The lever to the right, by leaving the dotted position, releases its pawl from its lifted point, drops it into the ratchet wheel, turning the latter as it moves forward to its limiting position; the amount of this motion is sufficient to separate the carbons for starting the arc. Before, however, the lever comes to a stop, it lifts the pawl out of the ratchet wheel by means of a stud, thus leaving the wheel free, but as at the same time the armature on the left with its lever comes into action, the outer pallet prevents the escapement wheel from returning, thus keeping the carbons separated.

When now the carbon points become too far apart by burning away, the current becomes feeble, the magnet on the left loses some of its power of attraction, and allows the spring between the lever and inner pallet to come into action which forces this lever with the outer pallet backwards, thereby allowing the escapement wheel to advance, and to press the inner pallet (which is pivoted to the upper end of the lever) forwards, and this permits the escapement wheel to advance $\frac{1}{8}$ths part of a tooth, which tooth is then stopped by the inner pallet.

By this action the carbons come sufficiently together to increase the current, and thus the magnet on the left gains power, the armature will slowly (it is somewhat curious, but a fact that this action takes place *slowly*) again be attracted, the lever presses the inner pallet against the stud, and causes this pallet to leave the escapement wheel, and then the outer pallet returns to the escapement wheel, thus allowing the latter to complete the other $\frac{1}{8}$th part of a tooth.

Through this alternating play of the two pallets into the escapement wheel its advance will be regulated step by step so as to ensure the maintenance of the right distance of the arc.

If no current passes the lamp both levers will be withdrawn so that there is nothing to prevent the carbon points from coming in contact at once.

The lever to the left will be withdrawn by the spiral spring, which spring is so weak that it only withdraws the lever, if no current passes the lamp, or if the lamp becomes extinguished. The feed action, as before described, is produced by the spring between the lever and inner pallet. This combination prevents the carbon from coming into actual contact while burning.

If the current should be suddenly broken or the lamp extinguished the carbon will thus immediately come in contact, and be relighted at once by the rapid action of the magnet to the right with its separating mechanism before described.

These regulators can be constructed for any current whether alternate or continuous.

Fig. B shows the form which the points of the carbon assume when alternate currents are used. Fig. A shows how one carbon can be set above the other so as to cause the light from the arc to be directed downwards.

Besides the foregoing, I have succeeded in the construction of candles with circular carbon pencils, in which no clockwork nor any mechanism is required for the feed of the carbon. In this arrangement, which is shown by figs. 3 and 4, two sets of circular carbon pencils cross each other, and the arc is started and maintained at their crossing points.

The lower set of circular carbon pencils is connected to the negative pole (if used for continuous currents), and the upper set, which crosses the lower set, is connected with the positive pole, and the upper set is movable, and fixed to the armature of an electro magnet. If no current passes through the candle, the upper set rests in contact with the lower. If a current passes, then the armature of the magnet will be attracted, and the arc be started between the crossing points of the two sets, in consequence of the upper set being withdrawn sufficiently from the lower set to maintain the required distance of the arc. The feed of the carbons takes effect without changing the distance of the arc, and is done entirely automatically through the weight of their respective holder arms.

These arms have on their turning point small bevel wheels, between which is geared a pinion—one to each set—this pinion prevents the arms from falling unequally, and keeps the burning point always in the same place. When alternate currents

REGULATORS

Fig.1.

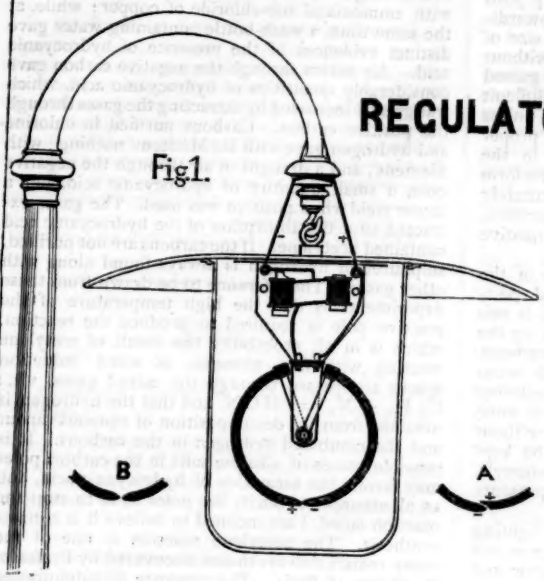
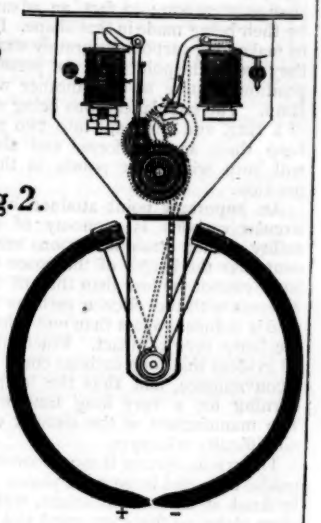


Fig.2.



CANDLES

Fig.3.

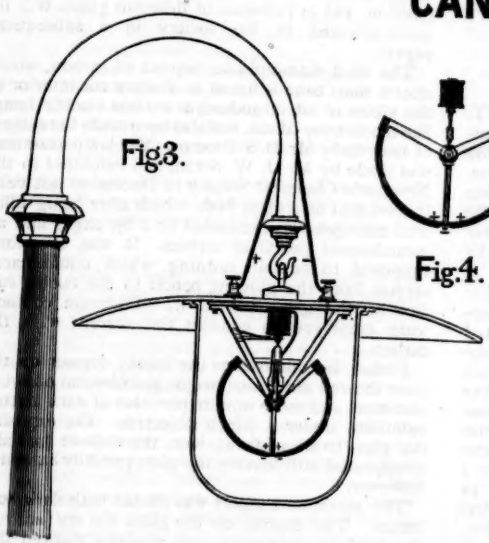
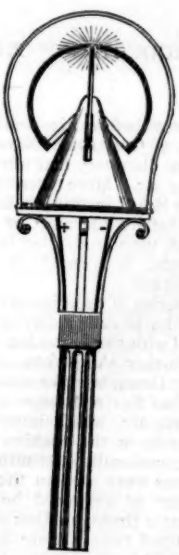


Fig.4.

Fig.5.



are used, all four points will become nearly pointed. Fig. 5 shows the candle arranged on a lamp post, the carbon points, in this case, being set upwards. These candles may be constructed for any size of light, and will burn from 10 to 24 hours without change of carbon; in fact, an advantage is gained by their being made in that shape. It is very difficult to make long carbons accurately straight, and unless they are so the points will not preserve their proper position relative to one another when set in the lamp. The circular carbons being made in the form of a ring, and then cut into two parts, accurately keep their annular form, and always, therefore, will burn with their points in the same relative position.

An important point attained by the use of the circular carbons is economy of space and portability; when straight carbons are used, it is evident that the length of the space occupied by the lamp cannot be less than that of the two carbons, whereas with the circular carbons the length occupied is reduced to less than one-third, thus rendering the lamp very compact. Practically, also, it must be evident that long carbons could be used without inconvenience, and thus the lamp could be kept burning for a very long time without renewals. The manufacture of the circular carbons presents no difficulty whatever.

The whole system is most economical for lighting public halls and large open places, as the lamps can be fixed at an unusual height, with a reflector and glass globe, so that rain, wind and dust would have no effect, whilst they will cast their light to a long distance.

PRODUCTS OF THE VOLTAIC ARC.

SHORTLY before his death, the late Professor T. Wills, of Greenwich Naval College, made the important discovery that nitric oxide is formed in the voltaic arc. More recently Professor James Dewar, of the Royal Institution, has determined the curious fact that hydrocyanic, or prussic acid, that deadly poison, usually distilled from laurel leaves or bitter almonds, is formed in small quantities in the voltaic arc.

A series of experiments favouring the conclusion that the so-called carbon lines are invariably associated with the formation of acetylene (as suggested by Plucker, Angstrom, and Thalén) induced Professor Dewar to make some experiments to ascertain whether this substance can be extracted from the electric arc, which invariably shows this peculiar spectrum at the positive pole, when it is powerful and occasionally intermittent. For this purpose the carbons were used in the form of tubes, so that a current of air could be drawn by means of an aspirator through either pole, and the products thus extracted from the arc, collected in water, alkalies, and other absorbents. Gases may be led through one of the poles, and suction induced through the other, in order to examine their effect on the arc. The experiments were made by means of the Siemens' and De Méritens' magneto machines. Hydrogen led in by the positive pole, and the gases extracted, gave the well-known acetylene compound with ammoniacal sub-chloride of copper; while, at the same time, a wash-bottle containing water gave distinct evidences of the presence of hydrocyanic acid. Air drawn through the negative carbon gave considerable quantities of hydrocyanic acid, which was greatly increased by extracting the gases through the positive carbon. Carbons purified in chlorine and hydrogen gave with De Méritens' nothing; with Siemens', and a draught of air through the negative pole, a small quantity of hydrocyanic acid, but a larger yield when positive was used. The gases extracted after the absorption of the hydrocyanic acid contained acetylene. If the carbons are not purified, sulphuretted hydrogen is always found along with other gases. The inference to be drawn from these experiments is that the high temperature of the positive pole is required to produce the reaction, which is in all probability the result of acetylene reacting with free nitrogen, as when induction sparks are passed through the mixed gases, viz.: $C_2 H_2 + N_2 = 2 H C N$, and that the hydrogen is obtained from the decomposition of aqueous vapour and the combined hydrogen in the carbons. It is possible traces of alkaline salts in the carbon poles may favour the formation of hydrocyanic acid, but, as all attempts to purify the poles so as to stop the reaction failed, I am inclined to believe it is a direct synthesis. The acetylene reaction is one of the many remarkable syntheses discovered by Professor Berthelot, of Paris. The presence of sulphuretted hydrogen is doubtless due to the reduction of the sulphates, invariably present in the ash of the carbon. A more complete examination of the various reactions to be brought about by means of the Siemens' arc, and with poles of varied composition, and in presence of different gases, will be communicated to the society in a subsequent paper.

The hard diamond-like deposit of carbon, which after a short time is found to obscure the interior of the globe of an incandescent carbon electric lamp, like the Sawyer-Mann, has also been made the subject of analysis by Mr. B. S. Proctor. The lamp examined was made by Mr. J. W. Sivan, and exhibited to the Newcastle Chemical Society in December last year. It consisted of a glass flask, which after being filled with nitrogen was exhausted by a Sprengel, and an incandescent pencil of carbon. It was, therefore, supposed to contain nothing which could carry carbon from the glowing pencil to the cooler surface of the glass around it. Platinum contacts were employed to connect the current with the carbon.

Under the microscope the smoky deposit on the glass showed numerous bright globules, no doubt of platinum, and more minute particles of dark matter, nebulous, under a $\frac{1}{4}$-inch objective. On exposing the glass to an oxidising heat, the deposit partially disappeared, still leaving the glass partially darkened however.

The platinum support was coated with dark sublimate. The deposit on the glass was not entirely dissolved by *aqua-regia*, and analysis showed that the soot contained platinum, carbon, and iron. The platinum globules might result from the disruptive discharge which took place at the moment the lamp failed.

Correspondence.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I observe from your description of the Siemens-Alteneck Alternating Current Machine, which was illustrated in your last issue, that the principle of the apparatus is that of employing flat circular bobbins moving through magnetic fields of alternating polarity. I would call your attention to the fact that the use of such an arrangement was described in my patent, No. 4,432, 1877, the illustration of the same being on sheet 6 of that specification.

I am, Sir, &c.,

London, 10th *September*. J. RAPIEFF.

Notes.

THE Belle-Cour Theatre at Lyons is to be lit by electricity.

THE *Journal Telegraphique*, for August 25th, contains a detailed *annexe* to the International Telegraph Convention of St. Petersburg, embodying the revision which took place during the recent conference at London.

EDISON'S latest electropyre, or electric burner, consists of a small cylinder of pure zircon, heated to whiteness by a surrounding coil of platino-iridium wire.

EDISON'S call for platinum for his electric lamp has been responded to with interest by Western "prospectors," and a crystalline vein of it has been found in a seam of talc in Santa Clara County, California. The schistose rock in which the talc is imbedded was found to be so hard, however, that the work of quarrying proved unprofitable. Prof. Stewart, nevertheless, thinks that with proper tools it might be made to pay. Drift platinum was once found along with gold in old diggings of Trinity and Humboldt Counties, and the same authority recommends search in that region.

THE s.s. *Faraday* has returned to the Thames after successfully laying the ocean section of the new French Atlantic Cable from Brest to St. Pierre, a distance of 1800 miles.

THE s.s. *Dacia* recently left for the Mediterranean to lay a duplicate cable between Marseilles and Algiers, which has been made by the India-rubber and Gutta-percha Telegraph Company. Mr. W. H. Preece, who recently suffered an injury to his leg which incapacitated him from active service, has, we believe, gone with her as a guest. Mr. Graves is also on board.

THE remains of the late Sir Rowland Hill, the originator of the penny postal system, were interred in Westminster Abbey on Thursday, September 4th, at noon. The funeral, which was very plain, was attended by many eminent men, statesmen, representatives of the postal department, and old friends. The service was conducted by Canon Duckworth.

CAPITAL PUNISHMENT BY ELECTRICITY.—Electricity is regarded by many as the probable means of legal punishment by death or torture; and the Paris papers are forcing these views to take a practical shape by discarding the guillotine and substituting a fatal electric shock instead. By electricity, they argue, instantaneous death can be inflicted without the hideous and unclean concomitants of the decapitating machine, and with the certainty that consciousness will not survive the stroke. We are not so sure of this latter result in all cases, at least at first, but; doubtless, steps would be taken to guard against miscarriage of penalty. The death would be painless, for it would occur before the organs of feeling could act, and therefore it would be humane. There is reason to believe that when the French Chamber reassembles a bill will be brought in to effect the end in question.

A CURIOUS ACOUSTICAL ILLUSION has been pointed out by M. Plumandon, of the Puy de Dome Observatory, which some of those who use a pair of telephones in receiving may have observed. With a single telephone held, say to the right ear, the transmitted voice appears to come from a distance to the right; while with a telephone held to the left ear, it seems to arrive from the left of the listener. With a telephone to each ear if one ear be less sensitive than the other, or if the telephone be held farther from that ear, the voice shifts to the side of the other ear; and if both ears hear alike and both instruments are equally near their respective ears, the voice apparently proceeds from in front of the observer.

A NEW comic opera to be produced in Baltimore, America, bears the name of "The Electric Light." Some talented low comedian, a Yankee Lionel Brough or J. L. Toole could make excellent capital out of a burlesque of Edison and his wonderful lamp. Here is an opportunity for histrionic fame.

OWING to the bad state of the telegraph lines to Morocco, messages are now sent by post from the South of Spain. Those for Tangiers, Tetuan, and the West Coast of Morocco should be addressed to the Spanish Telegraph office of Tarifa; those for Melila, Chafarinas, Peñon and Albrucemas, to Malaga, and those for Ceuta to Algesiras.

THE death is announced of Herr Lamont, director of the Observatory of Munich, and one of the fathers of electric meteorology.

MR. GADD, the registered proprietor and Mr. Allen, the publisher of the *Investigator*, appeared at the Guildhall Police court, on Thursday, September 4th, in answer to a summons charging them with having published defamatory libels, concerning Mr. Croll, the official liquidator of the United Kingdom Telegraph Company. Mr. Croll gave a general denial of the statements. Mr. Allen intimated through his council that as soon as he had found out that there was anything objectionable in the paper he had ceased to sell it, and requested that his name should no longer appear as publisher. The summons against Mr. Allen was thereupon withdrawn, and that against Mr. Gadd came on for hearing, on Tuesday, September 9th, when it was decided to commit the latter for trial.

MR. CLINTON G. COLGATE, the lawyer who recently obtained an injunction against the Western Union Company of America, for the use of gutta-percha covered wires and cables, has also obtained one against the Gold and Stock Company. The royalty which these companies will require to pay has not yet been decided upon. The Bishop Gutta-percha Company also pay a royalty for manufacture of such wires and cables; but

they are restrained from supplying these two companies until the litigation has been settled.

THE German-Norwegian Cable, *via* Sylt, has been successfully laid, the work being completed on the 22nd ult., when the town of Westerland at the Norwegian terminus of the line was decorated with the flags of Germany, Norway and England.

A NEW telegraph wire, especially applicable for military lines, is being made and tried in Germany. It consists of a compound iron and aluminum wire, combining lightness with strength and conductivity.

AN attempt is being made to establish a telephonic exchange in Manchester on the American plan. The apparatus to be employed is Bell's receiver and Blake's microphone transmitter.

ST. ELMO'S FIRE was recently witnessed on a magnificent scale in the Jura above St. Cergues. During a thunderstorm which overshadowed the region, a pine forest above St. Cergues was seen to blaze with a light like the phosphorescence of a tropical sea. After every discharge of lightning, however, the fire was momentarily extinguished. Rain had converted the trees of the forest into good conductors, and when the strongly-charged cloud passed over the bristling points of the firs, the induced discharge therefrom gave the whole forest a luminous appearance, which vanished for a time after every withdrawal of the exciting charge by lightning.

EDISON'S CHALK CYLINDER BATTERY.—It has been found by Edison that the chalk cylinder and platinum rubber which he employs in his electro-chemical telephone acts as a battery or generator of electricity giving an electro-motive force equal to half of that from a Daniell cell. Four of these cylinders of prepared chalk were mounted by him on a non-conducting axle, the platinum rubber of each being connected to the metallic boss or journal of the next, and on rotating the axle a current could be drawn off from the last rubber and the first boss of the series. These four cylinders are said to be equivalent to two Daniell cells, but the power varies somewhat with the speed of rotation. The battery has a resistance of 1,200 ohms. when at rest and only 50 ohms. when in motion for ¼-inch metallic surface of rubber. Whether the current is due to the chemical solution on the chalk has not yet been determined.

THE ELECTRIC RAY AND THE TELEPHONE.—Some time ago we chronicled the fact that M. Marey had studied the discharge of the electric eel by means of the telephone, and found it to consist of a rapid intermittent current. Taking the hint from M. Marey, another French *savant*, M. Ch. Robin, who first proved that the electric Ray had a battery in its tail, has been investigating the discharge of that animal by the same means. The wires leading from the telephone were terminated by metal plates, one of which was placed on the tail of the Ray near the two caudal fins, while the other was placed on the body itself at the base of the tail at a point where the electric apparatus of the animal is no longer under the skin. The telephone was, of course, applied to the ear of the observer. At each discharge from the larger Rays a dull sound was heard in the telephone, but of feeble volume compared to the sounds produced by the discharge of the eel or torpedo, owing to the small size of the Ray generator. The sound had in fact only a fourth of the intensity of that given by a young torpedo no larger than the palm of the hand.

DISTILLATION OF LIQUIDS UNDER THE INFLUENCE OF ELECTRICITY.—It has been found by M. Gernez that if a liquid be introduced into an inverted U tube, having the platinum electrodes inserted into its two extremities, and connected to a Holtz machine, and if the air is exhausted from the tube leaving the liquid to cover the electrodes, then on turning the machine so as to electrify the two columns of liquid, there will be a passage of liquid by evaporation from the positive to the negative pole. The action is distinct, regular, and, for certain liquids, rapid. This result has been shown by M. Gernez to be due not merely to the heating of the liquids; and he has found that the quantity of liquid transported is proportional to the quantity of electricity in play, and does not depend sensibly on the open surface of the liquid.

ROWLAND'S THEORY OF THE AURORA.—Professor Rowland, of Baltimore, has recently framed a theory of the *aurora borealis*, which is founded on the supposed electrification of the earth—for the most part on the exterior of the atmospheric envelope. According to it, air currents from the equator carry the electricity towards the poles, where the descending air leaves it, and the condensation thus produced in these regions is relieved by discharges, which appear under the guise of northern lights. The total effect of this process would thus be to cause a difference of potential between the earth and the upper regions of the air, both at the poles and the equator. At the poles, however, the discharge takes place in the dry atmosphere. At the equator, the electrostatic attraction of the earth, for the upper atmospheric layers, causes the atmosphere to be in unstable equilibrium. At some spot of least resistance, the upper atmosphere rushes toward the earth: moisture is condensed, and a conductor thus formed on which electricity can collect; and so the whole forms a conducting system, by which the electric potential of the upper air and the earth become more nearly equal. This is the phenomenon known as the thunderstorm. Hence, were the earth electrified, the electricity would be carried to the higher latitudes by convection, would there discharge to the earth as an *aurora*, and, passing back to the equator, would get to the upper regions as a lightning discharge, once more to go on an unending cycle.

ELECTRO-OPTIC PROPERTIES OF LIQUIDS.—In the *Philosophical Magazine* for August, Dr. J. Kerr, of Glasgow, publishes the details of a series of experiments on the power possessed by the silent electric discharge of inducing double refraction in various liquids. The mode of experimenting consisted as follows: the liquid to be tested was placed in a square glass cell, having brass discharging knobs let into two of its opposite walls, so that a discharge from an electric machine could be sent across it between the knobs. Through the liquid in the cell at right angles to the line of electric discharge, a beam of light from a flat paraffin flame, and polarised by passage through a Nicol prism, was sent; and between the cell and the observer's eye, the light passed through compensating plates of strained glass, a neutralising plate, and the analysing Nicol prism. When everything has been properly adjusted, the streak of polarised light reaching the observer's eye, is purposely extinguished; and then the discharge is applied to the liquid, with the effect of restoring the extinct light. With carbon disulphide, which is the best dielectric yet discovered, a small movement of the electro machine, one turn or less, gives a very fine restoration of the light in the polariscope. As the potential rises, the light increases steadily until it is quite brilliant; but if a spark be

taken upon the knuckle from the prime conductor of the machine at any point, the phenomenon instantly vanishes. Benzol, toluol, xylol, cumol, cymol, terebene, amylene, and carbon dichloride, were in this way found to be very good insulators by this apparatus, in comparing the striking distance of the prime conductor, when the wire connecting it with the cell was in and out of position successively. Valeric acid was found to be a poor insulator, as also was bromotoluol. Nitrobenzol gave no optical effect, and is really a good conductor. Young's paraffin oil, sp. gr. ·814, one of the lightest illuminants made, was found to be an excellent insulator; while another sample of sp. gr. ·890, one of the heaviest lubricants made, is also a good insulator; and no liquid which the author has yet examined, except $C S_2$ is superior to it in the strength and range of its electro-optic action.

WE have pleasure in directing the attention of such of our readers as are interested in photography to the gelatino-bromide dry plates of Messrs. Wratten and Wainwright. These gentlemen succeed in producing plates which for quality, rapidity, and simplicity of development, leave nothing to be desired. Having used them ourselves we do not hesitate to recommend them to all who wish to take photographs of electrical apparatus, and instruments, or retain mementos of the places where they are at present engaged.

A REMARKABLE portable camera, suitable for landscape work or portraits, is sold by the Sciopticon Company, for the small sum of 50s. This will take plates 6½ inches by 4½ inches. If a more substantial apparatus be desired, the amateur cannot do better than write to either of the above firms, who supply anything required in photography, and at most reasonable prices.

Reviews.

Instructions for Testing Lines, Batteries, and Instruments, and Guide to the Technical Arrangement of Telegraph Offices in India. By LOUIS SCHWENDLER. Second Edition. Vols. I. and II. Revised by R. S. Brough.

IT is now some years since the series of pamphlets, of which these volumes are a re-arrangement, were written. In issuing the Instructions in the present form, revisions and considerable additions have been made, and necessarily with great advantage. In the hands of such an experienced and able electrician as the late lamented Mr. Brough, much really useful matter has been added. Attention is called, in a memorandum at the commencement of Vol. I., to some of the chief alterations which have been made. The first of these relates to the nomenclature of units, in which we observe that the unit of "Quantity" has been called the "Weber," and the unit of "Current" the "Oersted." Whilst quite agreeing that these names would have been well chosen in the first instance, yet we must point out that the Committee of the British Association, in their report upon Electrical Standards, have assigned the name of "Weber" to the unit of *Current*, and not of *Quantity*, the latter being left without a name, an omission which is to be regretted. Mr. Brough is not, however, singular in his error, as we know of at least one other work in which the same mistake has been made.

In dealing with the theory of the Wheatstone bridge, although the questions involved have been well considered up to a certain point, there the matter has stopped, and the same omission has been made, to which we called attention in noticing Mr. Schwendler's Testing Instructions (the first volume of which was published a short time ago by Messrs. Trübner) viz.:—that, although the conditions for an absolute maximum of sensitiveness are given, yet it has not been shown how widely these conditions may be departed from without materially affecting the object in view. In most, if not all, cases of the kind, this divergence may be considerable; let us take a simple instance. The magnetic force, with a given current strength, produced by the coils of a galvanometer or electro-magnet, is proportional to the number of convolutions within a given space, and also, within a given space the number of convolutions is proportional to the square of the resistance g of the galvanometer or electro-magnet. The current strength flowing through the coils is inversely proportional to the total resistance in the circuit; hence, if we call R the external resistance, we shall have:—magnetic effect M is

$$M = \frac{\sqrt{g}}{g+R} \times K$$

where K is a constant depending upon the electromotive force of the battery, shape of the coil, &c.

Now, if we differentiate the fraction with respect to g, and put it equal to o, we then get the well-known proof that to obtain the maximum effect the resistance of the galvanometer or magnet should equal the external resistance; thus

$$\frac{d\,M}{d\,g} = \frac{1}{(g+R)^2}\left[(g+R)\frac{1}{2\sqrt{g}} - \sqrt{g}\right] = o$$

at a maximum; or

$$g + R = 2g$$

that is

$$g = R.$$

But now let us examine the magnetic effect equation. To do this let us put $R = ng$; we then have

$$M = \frac{\sqrt{\frac{R}{n}}}{\frac{R}{n} + R} K = \frac{1}{\sqrt{R}}\left[\frac{\sqrt{n}}{1+n}\right] K$$

Now, to obtain the maximum effect we must have $n = 1$, then

$$M = \frac{1}{\sqrt{R}} \times \frac{K}{2}$$

Let us now suppose $n = 9$, we then get

$$M = \frac{1}{\sqrt{R}} \times \left[\frac{\sqrt{9}}{1+9}\right] K = \frac{1}{\sqrt{R}} \times \frac{K}{3{\cdot}3}$$

or, in other words, although we have made g but $\frac{1}{9}$th of what should be its theoretical value in order to obtain maximum sensitiveness, yet by so doing the sensitiveness has only been reduced in the ratio of 3·3 to 2. Or, again, taking the case of the Wheatstone bridge, supposing that the theoretical resistance of the galvanometer for maximum sensitiveness in making a particular test had been 900 ohms, and supposing that when equilibrium had been nearly

but not quite arrived at, a deflection of the needle of 3·3 divisions from zero had been obtained, then if the resistance had been made 100 instead of 900, the deflection would only have been reduced to 2°. Precisely the same result is obtained if g is made nine times its proper value. It is a somewhat interesting fact that in determining the conditions for maximum sensitiveness in a very great number of tests, an equation of nearly the form first given is obtained, and an analysis made in the manner shown would yield very similar results.

The chapters on Line Testing contain a great deal of useful information, and, as a rule, are very free from the unnecessary formula which it is the fashion to overload books of the kind with, under the plea of making explanations clearer and tests more accurate.

The Indian wire gauge, which is employed in the telegraph service in India, and a table of which is given, we notice, is based on the weight per mile of the wire; this, for various reasons, is found to be a very convenient gauge.

In the chapter containing the foregoing, some interesting details are given concerning the state of efficiency of the insulation of the Indian lines and the great variation it undergoes during the day from climatic changes. Experiments made on the Hydrabad lines gave the insulation as 8 megohms per mile in the afternoon during September (S. W. monsoon); this fell to ·08 megohms per mile in the early morning, and then increased again one hundred fold as the day advanced. Considering that the lengths of the lines in India are such that, in making a test, the insulation resistances cannot be disregarded in comparison with the conductivity resistances, the difficulties in accurately localising faults from the continual variation of the insulation may well be imagined.

Attention is drawn, in the memorandum before referred to, to the addition in the book of De Sauty's capacity test. Now, we are inclined to think, from the fact of this test being given in most text books dealing with electrical testing, that it has never been made, except theoretically. Practically, the test is almost useless if any pretence to accuracy is required, the reason being that, when any approach to a balance becomes to be made, the quantity of electricity discharged through the galvanometer becomes so small, and of such extremely short duration, that *practical* balance is obtained long before *theoretical* balance is arrived at, even with a very sensitive Thomson galvanometer.

At the end of Vol. I., the system of compiling the tests is illustrated, and much valuable information is thus recorded, and that in a very convenient form.

Vol. II. of the work chiefly deals with testing and working apparatus; but, at the commencement, the testing of batteries, &c., with the tangent galvanometer, is both theoretically and practically considered, and that in a very clear manner, the conditions for making accurate tests being well examined.

The system of earth testing adopted hardly seems an entirely satisfactory one, as it practically can only show whether the resistances between the earth-plate and two other earths contiguous to them are small, and not whether the resistance between the particular station and other stations is small. If the station at which the tests were made, to take a suppositious case, stood in a rocky basin, which insulated it from the other parts of the country, the tests recommended would prove little or nothing of any value; they would prove whether the earth-plate itself were insulated, by its surface being completely oxidised or rusted (if of iron), but faulty earths are not always caused by such strictly local effects, though in many cases they are so, as is pointed out.

The local products of India seem in many cases very suitable for telegraph stores; sal-ammoniac is a common article of commerce for instance, and for cleaning the coppers and brass-work of the batteries "tamarind" water is found highly efficient.

In speaking of "double current" working, a fact not generally known is pointed out, viz., that this kind of working does not diminish retardation due to the electrostatic capacity of the line, a fallacy disposed of by Prof. Fleeming Jenkin, in a number of the *Philosophical Magazine* for 1863.

In the sections devoted to Duplex Telegraphy, the theories of the different systems are but briefly entered into, and nothing is lost by their being so treated. In comparing the "differential" with the bridge method it is shown that the former is more economical than the latter, as regards battery power, in the proportion of 4·0 to 2·4, and is less affected by variation of the line resistance in the proportion of 2·3 to 2·0. The quadruplex is also briefly explained, and a full illustrated description of Preece's railway block instruments, which are employed to some extent in India, completes the volumes, which are undeniably very useful and creditable productions.

Electric transmission of Power; its present position and advantages. By PAGET HIGGS, LL.D. London: E. & F. N. Spon.

THE scientific mind of the world is becoming awake to the fact that electricity will play an important part in the future as the swift vehicle of power. At present, very little has been done to make an economic success of electro-motive transmission; but still something has been done, and the feasibility of the process demonstrated. Dr. Higgs has, therefore, taken time by the forelock, and collected into a handy little book—we might rather say pamphlet—all the most reliable data on the subject, together with some of his own experimental results. He first describes the most prominent dynamo-electric machines, then considers the mechanical ratio of the efficiency of this mode of transmission and its applicability either to long or short distances, and finally sums up the most patent advantages of employing electricity for the purpose in hand. There are several valuable references throughout the book; but if the author had given a full list of authorities and papers on the question he would have materially assisted enquirers.

The fact, as pointed out by Professors Houston and Thomson, that electro-generators of 1,000 H.-P., as proposed at first by Dr. Siemens, are not really necessary for the transmission of power by electricity for great distances, that conductors of immense size are not required, and that some 48 per cent. of the original electric energy can be utilised for work,

combine to make the electrician sanguine as to the promise of this method of conveying power. This percentage of reclaimed energy is more than can be obtained from compressed air, and is almost as much as can be yielded by means of hydraulic transmission.

New Patents—1879.

3368. "Joinings for wire fences, telegraph wires and continuous lengths of wires or rods for other purposes." T. YOUNG. Dated Aug. 21.

3393. "Telephones." P. S. JUSTICE (communicated by S. H. Short). Dated Aug. 23.

3410. "Electric batteries." W. MORGAN BROWN (communicated by W. F. E. McCarty). Dated Aug. 25. Complete.

3436. "Galvanic batteries." R. C. ANDERSON. Dated Aug. 26.

3472. "Improved compounds or combination of ingredients for insulating and coating telegraph wires (submarine and land). A. WILKINSON. Dated Aug. 28.

3525. "Telegraphic recording apparatus." R. K. BOYLE. Dated Sept. 3.

3543. "Improvements in electro-magnetic induction apparatus and in the means of neutralising induced currents by the aid of such apparatus." R. H. COURTENAY. Dated Sept. 3.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.—1879.

211. "Producing and applying electric currents for lighting, &c." JOHN RAPIEFF. Dated Jan. 18. 1s. 10d. This describes a new dynamo-electric machine in which non-magnetic or dia-magnetic cores are employed in the electro-magnets to lessen absorption of the magnetism. Various plans for making and arranging the electro-magnets are also illustrated with different forms of Rapieff's electric lamp.

229. "Telephones." W. R. LAKE (communicated by F. Blake, Jr., of Weston, Mass., U.S.). Dated Jan. 20. 6d. This describes a microphonic telephone transmitter having both carbon electrodes or microphone contact pieces free to move with the diaphragm, instead of only one, as usually employed. One of these is made heavy so as to offer inertia to the rapid vibrations of the diaphragm.

259. "Lamp or apparatus for shading the electric or other lights, &c." T. W. GRIEVE. Dated Jan. 22. 6d. This consists in arranging coloured or opaque glass, or other shades for electric or other lights so that they can be raised or lowered in any order. The shades are lowered by means of a cord and pulleys.

277. "Electric lighting." SIGISMUND COHNÉ. Dated Jan. 22. 4d. This consists in making electric candles of ultramarine, either pure or mixed with carbon, kaolin, plaster of Paris, molasses, or powdered metal, preferably copper. The composite candles are made into a paste, moulded, and then baked to char the molasses and sublime the sulphur. They are constant in resistance and consume slowly. To increase the conductivity of the candle it is put into a zinc tube before being baked and the baking sublimates the zinc and drives it into the candle.

299. "Apparatus for producing light by electricity." H. J. HADDAN (communicated by E. Molera and J. Celrian, San Francisco, U.S.). Dated Jan. 24. 10d. This plan for distributing electric light by pipes and lenses was illustrated in the TELEGRAPHIC JOURNAL for July 15.

307. "Insulated wires and cables." W. MOSELEY Dated Jan. 24. 2d. The wire is covered with a jacket of horse-hair saturated with melted resin or gum mixed with oil to toughen it. It is then enclosed in a double sheathing of copper or other metal with tin between the double sheath. *Not proceeded with.*

315. "Apparatus for transmitting and receiving articulate and other sounds." F. A. GOWER and CORNELIUS ROOSEVELT. Dated Jan. 25. 6d. This describes Gower's well-known telephone. See TELEGRAPHIC JOURNAL for March 1.

332. "Obtaining currents of electricity." W. B. F. ELPHINSTONE, BARON ELPHINSTONE, and C. W. VINCENT. Dated Jan. 27. 6d. This describes a dynamo-electric machine in which the lines of terrestrial magnetic force are used to assist the artificial magnetic field.

General Science.

THE SEA-MOLE AND BI-AUTOMATIC GRAPNEL.—An ingenious diving-bell, called the "Sea-Mole," was on view in the Italian section of the Paris Exhibition. It is the invention of Signor Toselli, and consists of a hermetically closed iron cabinet or bell, containing a reservoir of air. It can be steered by the diver himself, and he can descend or rise in the water with it at pleasure. Lead weights and air pipes are consequently dispensed with, but a rope in connection with the surface is necessary. It is furnished with the electric light, which the diver can set glowing. There are glass windows for him to see by, and holes to put out grapnels, to grasp kegs, boxes, and other objects on the bottom, as well as artificial hands to seize pearl oysters, sponges, shell-fish, submarine cables, or shears to cut torpedo wires.

A SCIENTIFIC PROPHECY.—The discovery of the planet Neptune, after it had been foretold by Adams and Leverrier, the realisation of Mendelejeff, the Russian chemist's prediction, that certain chemical elements existed, are well-known instances of scientific prophecy; but a more recent and not less remarkable case has occurred in Mr. Pliny Earle Chase's harmonically indicated planets. Mr. Chase, detecting a harmonic relation (foreshadowed by Bode's law) between the mean distances of the planets and the sun, was led to suspect the existence of three intra mercurial planets. His arguments were published in the *American Philsophical Society* for 1873. Now it appears that the third of these planets seems to be the interior planet lately discovered by Prof. Watson. The elements of the planet are as follows:

	Distance.	Time.
As computed by Gaillot -	·164	24·25 days.
As predicted by Chase - -	·165	24·50 ,,

The other two predicted planets remain as yet undiscovered.

A MONUMENT is to be raised to Julius Robert Mayer.

PINTSCH'S RAILWAY LIGHTS.—Mr. Julius Pintsch's system for lighting railway trains, or other vehicles, buoys, and steamers, is perhaps the most successful of

all the plans for lighting carriages by gas. It is used on many of the German and Russian railways, the Prussian mail trains and state carriages, and has been adopted by the Metropolitan Railway Company in England. The gas employed is oil-gas, distilled from refuse petroleum or grease in retorts specially designed by Mr. Pintsch. It is compressed to six atmospheres into two holders fitted underneath each carriage. These two holders supply the four lamps necessary for the four compartments of the carriage, one jet being sufficient to light a compartment sufficiently to enable travellers to read during a night journey. The gas is supplied to the lamps by pipes through the medium of an automatic regulator, which maintains the stream of gas uniform, and thus provides a steady light whatever be the oscillations of the carriage. This regulator is an essential feature in the success of the system. It operates by means of a lever controlling a valve in the pipe, the lever being actuated by the pressure of the gas on a membrane. The burner employed is a small fish-tail; and there is a device for suddenly lowering the light in the case of trains passing through tunnels and daylight spaces alternately. Pintsch's plan gained the 1877 gold medal offered by the Society of Arts for railway lamps, and also Exposition medals at Moscow, Vienna, &c. Its economy over coal gas or oil lighting is nearly 50 per cent., and the light which it gives is superior to these methods. Oil gas is richer than coal gas, and gives 3½ times the illuminating power. In addition it does not lose its hydro-carbons so readily by compression, hence its employment by Mr. Pintsch.

MICHAUD'S PHOTOTYPES.—M. Michaud, a Parisian chemist, has succeeded in taking metallic casts from bichromated gelatine plates, directly engraved by photography. The process consists in melting an alloy of mercury and d'Arcet metal (an alloy of bismuth, tin, and lead) in a metal box, and gently impressing the graved gelatine plate face downwards on the surface of the fluid metal. When the metal has cooled again it becomes hard, and the negative can be separated from it, leaving the cast which can be utilised for blocks in typographic printing, or in lithography. Electrotypes may also be made from it for copper-plate printing.

City Notes.

Old Broad Street, Sept. 11th, 1879.

MEDITERRANEAN EXTENSION TELEGRAPH COMPANY (LIMITED).—The 44th ordinary general meeting of the shareholders of the above Company was held on Tuesday, August 26th, at the Cannon Street Terminus Hotel, under the presidency of Sir James Carmichael, Bart., the Chairman of the Company. The report of the directors for the half-year ended the 30th June last stated that there was a slight improvement over the previous half year, which was as much as could be expected under the protracted depression of commerce everywhere prevalent. The balance of the cost of repairing the cables referred to in the last report had entailed the necessity of applying to the Treasury for the full amount due under the guarantee. A telegraph conference had lately been held in London, at which the delegates of the various governments revised the rules and regulations affecting the international service, and determined to substitute a word tariff in Europe in place of the present system of charging the same sum for a message of twenty words, or less than twenty words. The Company's cables were in efficient working order. They recommended the payment of the usual dividend at the rate of 8 per cent. per annum on the preference stock, less income tax, and of a dividend at the rate of 3 per cent. per annum, free of income tax, on the ordinary stock, payable on and after the 1st proximo.

The revenue account stated that the receipts for messages during the half year had been £2,072, and the amount due from the Government under the guarantee was £3,600. The expenses of the offices and stations came to £1,877, the repairs of the Malta and Corfu cables to £2,140, and the amount available for dividends was £3,053.—The chairman in moving the adoption of the report, stated that he did not intend to detain them at any length, or to make any special observations, but he wish to call their attention to one subject—The Telegraph Conference. The conference was held in London, and sat for some weeks, and the Company was represented at it by their secretary, Mr. Tombs. After considerable discussion, it was ultimately decided that a general word-rate should be adopted throughout Europe. This was a great change to make, and, as regarded its effect on the receipts of the Company, it was very difficult to predict, but his individual belief was that it would be beneficial to the Company, as small traders, those interested in the fruit, vegetable, and fish trades, would be more disposed to pay fifteen centimes per word instead of, as at present, so many francs per message of twenty words.—The Hon. Ashley Ponsonby seconded the motion.—Mr. Robinson suggested that some provision should be made to prepare against the termination of the subsidy.—The Chairman said if the shareholders were willing for this purpose to forego 50 per cent. of their dividend, the Board would have no objection. They would consider the proposal between this and next meeting. The report was then adopted, and the dividends recommended declared. The retiring directors, Mr. Gurney and Captain A. T. Hamilton, were re-elected, as were also Messrs. Allwright and Robinson, the retiring auditors, and the proceedings then terminated in the usual manner.

The following are the final quotations of telegraphs:—Anglo-American, Limited, 52¾-53¼; Ditto, Preferred, 81¾-82¼; Ditto, Deferred, 26¾-27¼; Brazilian Submarine, Limited, 6¾-7; Cuba, Limited, 7¼-8; Cuba, Limited, 10 per cent. Preference, 15⅝-16⅛; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 11¼-11¾; Direct United States Cable, Limited, 1877, 10¼-10½; Eastern, Limited, 7¾-8; Eastern, 6 per cent. Debentures repayable October, 1883, 105-108; Eastern 5 per cent. Debentures repayable August, 1878, 101-103; Eastern, 6 per cent. Preference, 11⅞-12⅛; Eastern Extension, Australasian and China Limited, 7¾-8; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 105-108; 5 per cent. Australian Gov. Subsidy Deb. Scrip, 1900, par 1 pm; Ditto, registered, repayable 1900, par 2 pm; German Union Telegraph and Trust, 7⅛-8; Globe Telegraph and Trust, Limited, 4¾-5; Globe, 6 per cent. Preference, 11-11¼; Great Northern, 8¼-8⅝; Indo-European, Limited, 21-22; Mediterranean Extension, Limited, 2½-3; Mediterranean Extension, 8 per cent. Preference, 9-9½; Reuter's, Limited, 9-10; Submarine, 222-227; Submarine Scrip, 2-2¼; West Coast of America, Limited, 1-1⅛; West India and Panama, Limited, 1¼-1½; Ditto, 6 per cent. First Preference 7-7½; Ditto, ditto, Second Preference, 6¾-7¼; Western and Brazilian, Limited, 3-3¼; Ditto, 6 per cent. Debentures "A," 94-98, Ditto, ditto, ditto, "B," 87-92; Western Union of U. S. 7 per cent., 1 Mortgage (Building) Bonds, 118-122; Ditto, 6 per cent. Sterling Bonds, 104-106; Telegraph Construction and Maintenance, Limited, 31-31¼; Ditto, 6 per cent. Bonds, 106-108; Ditto, Second Bonus Trust Certificates, 2⅛-2⅜; India Rubber Co., 12-12½; Ditto, 6 per cent. Debenture, 103-108.